POSTERS

Planetary Evolution

Detection of Cometary Amines in Samples Returned by the Stardust Spacecraft

Daniel P. Glavin[1], Jason P. Dworkin[1], J. E. Elsila[1], Scott A. Sandford[2]

[1]NASA Goddard Space Flight Center, Greenbelt MD 20771, USA; [2]NASA Ames Research Center, Moffett Field CA 94035, USA

The delivery of amino acids to the early Earth by comets and their fragments could have been a significant source of the early Earth's prebiotic organic inventory that led to the emergence of life (Chyba and Sagan, 1992). Over 20 organic molecules including methane, ethane, ammonia, cyanic acid, formaldehyde, formamide, acetaldehyde, acetonitrile, and methanol have been identified by radio spectroscopic observations of the comae of comets Hale-Bopp and Hyakutake (Crovisier et al. 2004). These simple molecules could have provided the organic reservoir to allow the formation of more complex prebiotic organic compounds such as amino acids.

After a 7-year mission, the Stardust spacecraft returned to Earth samples from comet Wild 2 on January 15, 2006 providing the opportunity to analyze the organic composition and isotopic distribution of cometary material with state-of-the-art laboratory instrumentation. The Preliminary Examination Team analyses of organics in samples returned by Stardust were largely focused on particles that impacted the collector aerogel and aluminum foil (Sandford et al. 2006). However, it is also possible that Stardust returned a "diffuse" sample of gas-phase organic molecules that struck the aerogel directly or diffused away from the grains after impact. To test this possibility, samples of Stardust flight aerogel and foil were carried through a hot water extraction and acid hydrolysis procedure to see if primary amine compounds were present in excess of those seen in controls. Here we report highly sensitive liquid chromatography time-of-flight mass spectrometry measurements of amino acids and amines in samples returned from a comet (Glavin et al. 2008).

A suite of amino acids and amines including glycine, L-alanine, methylamine (MA), and ethylamine (EA) were identified in the Stardust bulk aerogel. With the exception of MA and EA, all other primary amines detected in comet-exposed aerogels were also present in the aerogel witness tile that was not exposed to Wild 2, suggesting that most amines are terrestrial in origin. However, the enhanced abundances of MA, EA, and possibly glycine in comet-exposed aerogel compared to controls, coupled with MA to EA ratios (1 to 2) that are distinct from preflight aerogels (7 to 10), suggest that these amines were captured from Wild 2. It is possible that MA and EA were formed on energetically processed icy grains containing methane, ethane, and ammonia. The presence of cometary amines in Stardust material supports the hypothesis that comets were an important source of prebiotic organics on the early Earth. To better understand their origin, a systematic compound specific carbon isotopic analysis (C-CSIA) via gas chromatography quadrupole mass spectrometry in with parallel with combustion isotope ratio mass spectrometry (GC–QMS/IRMS) is being conducted. We will discuss our latest C-CSIA measurements and what they indicate about the origin of amino acids extracted from Stardust samples.

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E-mail: daniel.p.glavin@nasa.gov

Gamma-Ray Bursts and Giant Flares Effects on the Early Evolution of the Biosphere

J. E. Horvath, D. Galante

IAG-USP, Sao Paulo U

We present in this talk a unified, quantitative synthesis of analytical and numerical calculations of the effects caused on an Earth-like planet by a Gamma-Ray Burst (GRB) and nearby giant flares from Soft-Gamma Repeaters, considering atmospheric and biological implications (Thomas & Mellot, 2006). The main effects of a GRB/giant flare are classified in four distinct types and analyzed separately, namely the direct radiation transmission, UV flash, ozone layer depletion and cosmic rays. The "effectiveness" of each of these effects is compared and critical distances for significant biological damage are given for each one (Galante & Horvath, 2007).

We find that the first three effects have potential to cause global environmental changes and biospheric damages, even if the source is located at great distances (from a few to hundred kpc, see Thorsett 1995), however, cosmic rays would only be a serious threat for very close GRB sources. Therefore, the question of the rate of events along the history of the galaxy has to be considered, and the importance of the search for signatures stressed (Scalo & Wheeler, 2002). In the case of the rare, nearby sources SGR we evaluate, using the same criteria for the softer spectra and other observed features (which greatly helps for the assessment of actual damages), the probability of a giant flare within a given distance. The result is that this class of sources should be considered as a substantial biological agent giving radiation "jolts" to the biota affected by their incidence.

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E-mail: foton@astro.iag.usp.br